APPENDIX A

FIELD SAMPLING AND ANALYSIS PLAN FOR SURFACE SOIL AT THE BABY BAINS GAP ROAD RANGES

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A.1.0 Introduction

The screening-level ecological risk assessment (SLERA) for the Baby Bains Gap Road (BBGR) Ranges (Shaw Environmental, Inc., 2004) identified antimony, beryllium, copper, lead, and zinc as chemicals of potential ecological concern (COPEC) in surface soil. To provide information for the baseline ecological risk assessment (BERA), surface soil samples will be collected from within the investigation areas and analyzed for target analyte list (TAL) metals, volatile organic compounds (VOC), semivolatile organic compounds (SVOC), chlorinated pesticides, organophosphorus pesticides, chlorinated herbicides, pH, total organic carbon, and grain size. In addition, these same surface soil samples will be used to assess the toxicity to earthworms and terrestrial plants, and the bioaccumulation potential of COPECs in surface soil to earthworm tissues. Soil-to-worm accumulation factors will be developed for use in food chain modeling to higher trophic level receptors that reside in and around the BBGR Ranges.

A.2.0 Selection of Sample Locations

Surface soil sample locations for the BERA are based on the full range of lead concentrations detected in surface soils during previous investigations. Because lead has been identified as a COPEC at all of the BBGR Ranges and has been used as one of the indicators of potential contamination from Army activities at small arms ranges at Fort McClellan, ecological sample locations will be based upon lead concentrations.

Data in the scientific literature indicate that phytotoxicity can occur in soils with lead concentrations as low as 110 mg/kg (U.S. Environmental Protection Agency [EPA], 2005) and that terrestrial invertebrate toxicity can occur in soils with lead concentrations greater than 5,940 mg/kg (Neuhauser et al., 1985). Additionally, data collected for the Iron Mountain Road and Bains Gap Road Ranges BERA indicated terrestrial invertebrate toxicity due to lead in soil at concentrations as low as 779 mg/kg. Based on this broad range of lead in soil that has the potential to pose adverse effects on terrestrial plants and/or terrestrial invertebrates, a range of lead in soil was identified for assessment in this BERA. The range of lead in soil that will be the focus of this BERA has been identified as between 100 mg/kg and 5,000 mg/kg, with the majority of the samples collected in the 100 to 800 mg/kg range. Nine surface soil samples will be collected from the BBGR Ranges that represent this range of lead in soil. These soil sampling locations were summarized and presented in Table 9-1 of the BERA Problem Formulation and Study Design report and are also summarized below.

Sample ID	Lead Concentration (mg/kg)	Sample Location
HR-74Q-GP52	111	Range 18
HR-118Q-GP05	214	Range 25
HR-74Q-GP63+200SE	359	Range 18
HR-79Q-GP31	539	Range 23
HR-79Q-SS09	644	Range 23
HR-84Q-GP29	827	Range 26
HR-79Q-SS06	1,000	Range 23
HR-74Q-GP66	3,040	Range 18
HR-118Q-DEP01	4,950	Range 25

In addition, one surface soil sample will be collected from a non-impacted area within or adjacent to Fort McClellan and will represent the reference location. Figure 9-1 in the BERA Problem Formulation and Study Design report presents the approximate locations of the surface soil samples representative of the lead concentration gradient at the BBGR Ranges.

A.3.0 Sampling and Analysis Requirements

The following sections present the soil sampling and analysis requirements for the earthworm toxicity and bioaccumulation studies and the terrestrial plant toxicity studies and the terrestrial plant accumulation analyses in conjunction with the BERA for the BBGR Ranges.

A.3.1 Sample Confirmation

Prior to the collection of soil for analytical and toxicological testing, lead concentrations at the selected sample locations will be screened in-situ using x-ray fluorescence (XRF) technology to verify that the selected locations are appropriate (i.e., lead concentration) for the intended lead gradient. XRF methodology will follow the procedures outlined in the installation-wide sampling and analysis plan (IT, 2002).

A.3.2 Sample Collection Procedures

Once the lead concentrations have been confirmed using XRF, soil will be collected to a depth of 0.5 feet, using a stainless-steel hand auger or spoon and homogenized in a stainless-steel bowl, following the sampling procedures outlined in the installation-wide sampling and analysis plan (IT, 2002). Soil samples will then be transferred to the appropriate sample containers. Visible

bullets and lead fragments will be removed from the sample prior to being transferred to the sample containers. Samples for chemical analysis and toxicity testing will not be sieved.

A.3.3 Decontamination Procedures

All equipment used for collection, homogenization, and transfer will be properly decontaminated prior to collecting samples and between sampling locations, as described in the installation-wide sampling and analysis plan (IT, 2002).

A.3.4 Quality Assurance/Quality Control Samples

As established by the data quality objectives process, field and laboratory quality assurance/quality control indicator soil samples and analyses will be collected to provide information concerning the measured quality and usability of the field data. As presented in the installation-wide sampling and analysis plan (IT, 2002), the frequency of field duplicates, matrix spike/matrix spike duplicates, and equipment rinse blanks will be 1 in 10 (10 percent), 1 in 20 (5 percent), and once per sampling event, respectively.

As presented in the earthworm toxicity/bioaccumulation and terrestrial plant toxicity test protocols (Sections 3.6.2 and 3.6.3), both a reference and laboratory control sample will be used to ensure the quality of the biological testing.

A.3.5 Sample Labeling, Packaging, and Shipment

All prepared samples will be labeled, packaged, and shipped to the appropriate analytical or biological testing laboratory as presented in the installation-wide sampling and analysis plan (IT, 2002).

A.3.6 Analysis

Analysis of surface soil samples will consist of chemical analysis, earthworm toxicity tests, earthworm bioaccumulation tests, and terrestrial plant toxicity tests. These analyses are described below.

A.3.6.1 Chemical Analyses

As presented in Table A-1, chemical analyses of soils collected for earthworm toxicity, earthworm bioaccumulation, and terrestrial plant toxicity studies will include TAL metals, VOCs, SVOCs, chlorinated pesticides, organophosphorus pesticides, chlorinated herbicides, total organic carbon, pH, and grain size. Chemical analyses of earthworm tissue after termination of the toxicity tests will include TAL metals (Table A-2) and chemical analyses of terrestrial plant tissues collected on-site and from a reference location will include TAL metals (Table A-3).

Table A-1

Surface Soil Sample Designations and Quality Assurance/Quality Control Samples
BERA Study Design for the Baby Bains Gap Road Ranges
Fort McClellan, Alabama

Sample Location	Sample Designation	Sample Depth (ft)	QA/QC Samples		Analytical Parameters
			Field Duplicates[a]	MS/MSD[a]	
HR-74Q-GP52	HR-74Q-GP52-SS-RW0001-REG	0 - 0.5			VOCs by 8260B, SVOCs by 8270C, Chlorinated Pesticides by 8081A, Organophosphorus Pesticides by 8141A, Chlorinated Herbicides by 8151A, and TAL Metals by SW6010B/ SW7471A. TOC by Walkley Black, pH by SW9045C, Grain Size by ASTM 421/422, 28-day Earthworm Survival and Growth Test, 28-day Perennial Ryegrass Germination and Growth Test.
HR-118Q-GP05	HR-118Q-GP05-SS-RW0002-REG	0 - 0.5	HR-118Q-GP05-SS-RW0003-FD		VOCs by 8260B, SVOCs by 8270C, Chlorinated Pesticides by 8081A, Organophosphorus Pesticides by 8141A, Chlorinated Herbicides by 8151A, and TAL Metals by SW6010B/ SW7471A. TOC by Walkley Black, pH by SW9045C, Grain Size by ASTM 421/422, 28-day Earthworm Survival and Growth Test, 28-day Perennial Ryegrass Germination and Growth Test.
HR-74Q-GP63+200SE	HR-74Q-GP63+200SE-SS-RW0004-REG	0 - 0.5			VOCs by 8260B, SVOCs by 8270C, Chlorinated Pesticides by 8081A, Organophosphorus Pesticides by 8141A, Chlorinated Herbicides by 8151A, and TAL Metals by SW6010B/ SW7471A. TOC by Walkley Black, pH by SW9045C, Grain Size by ASTM 421/422, 28-day Earthworm Survival and Growth Test, 28-day Perennial Ryegrass Germination and Growth Test.
HR-79Q-GP31	HR-79Q-GP31-SS-RW0005-REG	0 - 0.5			VOCs by 8260B, SVOCs by 8270C, Chlorinated Pesticides by 8081A, Organophosphorus Pesticides by 8141A, Chlorinated Herbicides by 8151A, and TAL Metals by SW6010B/ SW7471A. TOC by Walkley Black, pH by SW9045C, Grain Size by ASTM 421/422, 28-day Earthworm Survival and Growth Test, 28-day Perennial Ryegrass Germination and Growth Test.
HR-79Q-SS09	HR-79Q-SS09-SS-RW0006-REG	0 - 0.5		HR-79Q-SS09-SS-RW0006-MS/MSD	VOCs by 8260B, SVOCs by 8270C, Chlorinated Pesticides by 8081A, Organophosphorus Pesticides by 8141A, Chlorinated Herbicides by 8151A, and TAL Metals by SW6010B/ SW7471A. TOC by Walkley Black, pH by SW9045C, Grain Size by ASTM 421/422, 28-day Earthworm Survival and Growth Test, 28-day Perennial Ryegrass Germination and Growth Test.
HR-84Q-GP29	HR-84Q-GP29-SS-RW0007-REG	0 - 0.5			VOCs by 8260B, SVOCs by 8270C, Chlorinated Pesticides by 8081A, Organophosphorus Pesticides by 8141A, Chlorinated Herbicides by 8151A, and TAL Metals by SW6010B/ SW7471A. TOC by Walkley Black, pH by SW9045C, Grain Size by ASTM 421/422, 28-day Earthworm Survival and Growth Test, 28-day Perennial Ryegrass Germination and Growth Test.

Table A-1

Surface Soil Sample Designations and Quality Assurance/Quality Control Samples
BERA Study Design for the Baby Bains Gap Road Ranges
Fort McClellan, Alabama

Sample Location	Sample Designation	Sample Depth (ft)	QA/QC Samples		Analytical Parameters
			Field Duplicates[a]	MS/MSD[a]	
HR-79Q-SS06	HR-79Q-SS06-SS-RW0008-REG	0 - 0.5			VOCs by 8260B, SVOCs by 8270C, Chlorinated Pesticides by 8081A, Organophosphorus Pesticides by 8141A, Chlorinated Herbicides by 8151A, and TAL Metals by SW6010B/ SW7471A. TOC by Walkley Black, pH by SW9045C, Grain Size by ASTM 421/422, 28-day Earthworm Survival and Growth Test, 28-day Perennial Ryegrass Germination and Growth Test.
HR-74Q-GP66	HR-74Q-GP66-SS-RW0009-REG	0 - 0.5			VOCs by 8260B, SVOCs by 8270C, Chlorinated Pesticides by 8081A, Organophosphorus Pesticides by 8141A, Chlorinated Herbicides by 8151A, and TAL Metals by SW6010B/ SW7471A. TOC by Walkley Black, pH by SW9045C, Grain Size by ASTM 421/422, 28-day Earthworm Survival and Growth Test, 28-day Perennial Ryegrass Germination and Growth Test.
HR-118Q-DEP01	HR-118Q-DEP01-SS-RW0010-REG	0 - 0.5			VOCs by 8260B, SVOCs by 8270C, Chlorinated Pesticides by 8081A, Organophosphorus Pesticides by 8141A, Chlorinated Herbicides by 8151A, and TAL Metals by SW6010B/ SW7471A. TOC by Walkley Black, pH by SW9045C, Grain Size by ASTM 421/422, 28-day Earthworm Survival and Growth Test, 28-day Perennial Ryegrass Germination and Growth Test.
Reference [b]	REF-SS-RW0011-REG	0 - 0.5			VOCs by 8260B, SVOCs by 8270C, Chlorinated Pesticides by 8081A, Organophosphorus Pesticides by 8141A, Chlorinated Herbicides by 8151A, and TAL Metals by SW6010B/ SW7471A. TOC by Walkley Black, pH by SW9045C, Grain Size by ASTM 421/422, 28-day Earthworm Survival and Growth Test, 28-day Perennial Ryegrass Germination and Growth Test.

[a] Field duplicates and MS/MSDs are collected for chemical analysis only and not for biological testing.

[b] Reference location will be selected from an off-site location.

ASTM - American Society of Testing and Materials.
FD - Field duplicate.
FS - Field split.
MS/MSD - Matrix spike/matrix spike duplicate.
PCBs - Polychlorinated biphenyls.
QA/QC - Quality assurance/quality control.
REG - Field sample.
TAL - Target analyte list.
TOC - Total organic carbon.
VOC - Volatile organic compound.
SVOC - Semivolatile organic compound.

Table A-2

Earthworm Tissue Sample Designations
BERA Study Design for the Baby Bains Gap Road Ranges
Fort McClellan, Alabama

Sample Location	Sample Designation	QA/QC Samples			Analytical Suite
		Field Duplicates	Field Splits	MS/MSD	
HR-74Q-GP52	HR-74Q-GP52-WORM-RW7001W-REG				TAL Metals by SW6010B/SW7471A
	HR-74Q-GP52-WORM-RW7002W-REG				TAL Metals by SW6010B/SW7471A
	HR-74Q-GP52-WORM-RW7003W-REG				TAL Metals by SW6010B/SW7471A
HR-118Q-GP05	HR-118Q-GP05-WORM-RW7004W-REG				TAL Metals by SW6010B/SW7471A
	HR-118Q-GP05-WORM-RW7005W-REG				TAL Metals by SW6010B/SW7471A
	HR-118Q-GP05-WORM-RW7006W-REG				TAL Metals by SW6010B/SW7471A
HR-74Q-GP63+200SE	HR-74Q-GP63+200SE-WORM-RW7007W-REG				TAL Metals by SW6010B/SW7471A
	HR-74Q-GP63+200SE-WORM-RW7008W-REG				TAL Metals by SW6010B/SW7471A
	HR-74Q-GP63+200SE-WORM-RW7009W-REG				TAL Metals by SW6010B/SW7471A
HR-79Q-GP31	HR-79Q-GP31-WORM-RW7010W-REG				TAL Metals by SW6010B/SW7471A
	HR-79Q-GP31-WORM-RW7011W-REG				TAL Metals by SW6010B/SW7471A
	HR-79Q-GP31-WORM-RW7012W-REG				TAL Metals by SW6010B/SW7471A
HR-79Q-SS09	HR-79Q-SS09-WORM-RW7013W-REG				TAL Metals by SW6010B/SW7471A
	HR-79Q-SS09-WORM-RW7014W-REG				TAL Metals by SW6010B/SW7471A
	HR-79Q-SS09-WORM-RW7015W-REG				TAL Metals by SW6010B/SW7471A
HR-84Q-GP29	HR-84Q-GP29-WORM-RW7016W-REG				TAL Metals by SW6010B/SW7471A
	HR-84Q-GP29-WORM-RW7017W-REG				TAL Metals by SW6010B/SW7471A
	HR-84Q-GP29-WORM-RW7018W-REG				TAL Metals by SW6010B/SW7471A
HR-79Q-SS06	HR-79Q-SS06-WORM-RW7019W-REG				TAL Metals by SW6010B/SW7471A
	HR-79Q-SS06-WORM-RW7020W-REG				TAL Metals by SW6010B/SW7471A
	HR-79Q-SS06-WORM-RW7021W-REG				TAL Metals by SW6010B/SW7471A
HR-74Q-GP66	HR-74Q-GP66-WORM-RW7022W-REG				TAL Metals by SW6010B/SW7471A
	HR-74Q-GP66-WORM-RW7023W-REG				TAL Metals by SW6010B/SW7471A
	HR-74Q-GP66-WORM-RW7024W-REG				TAL Metals by SW6010B/SW7471A
HR-118Q-DEP01	HR-118Q-DEP01-WORM-RW7025W-REG				TAL Metals by SW6010B/SW7471A
	HR-118Q-DEP01-WORM-RW7026W-REG				TAL Metals by SW6010B/SW7471A
	HR-118Q-DEP01-WORM-RW7027W-REG				TAL Metals by SW6010B/SW7471A
SS-REF	SS-REF-WORM-RW7028W-REG				TAL Metals by SW6010B/SW7471A
	SS-REF-WORM-RW7029W-REG				TAL Metals by SW6010B/SW7471A
	SS-REF-WORM-RW7030W-REG				TAL Metals by SW6010B/SW7471A

FD - Field duplicate.
FS - Field split.
MS/MSD - Matrix spike/matrix spike duplicate.
QA/QC - Quality assurance/quality control.
REG - Field sample.
TAL - Target analyte list.
TOC - Total organic carbon.
SS-REF - Surface soil reference location collected from an off-site location.

A.3.6.2 Earthworm Toxicity Testing

Surface soil used for earthworm toxicity and bioaccumulation testing will be "split" from the soil samples used for chemical analysis. The 28-day earthworm survival tests and the earthworm bioaccumulation tests will be conducted using the earthworm *Eisenia fetida*.

A.3.6.2.1 Test Initiation

Earthworm toxicity/bioaccumulation tests will begin within 10 days of test soil collection. Immediately prior to testing, the temperature of the test soils will be adjusted to 20 ± 2 degrees Celsius (°C). Test conditions are presented in Table A-3.

Test soils will be hydrated with deionized water to create a moist testing environment. The earthworm test soils will be hydrated to 75 percent of water holding capacity. Ten earthworms will be placed into each of five replicate containers each containing 200 grams (dry weight) of test soil. The earthworms will be placed on the surface of the test soil in a pint jar, capped, and secured. The tests will be incubated within an environmental chamber to give soil temperature of 20 ± 2°C under continuous light. Lighting will be at continuous ambient laboratory levels, which is approximately 540 to 1,080 lux, with no shading.

A.3.6.2.2 Termination of the Test

Mortality will be assessed after 14 and 28 days (termination of the test) by emptying the test soil onto a tray and sorting the worms from the soil. Dead worms will be separated from the live worms and live worms will be placed back into their test jars and placed on the surface of the soil. The numbers of live and dead worms in each test chamber will be recorded at 14 days and at the termination of the test (28 days). The total weight of living earthworms in each test chamber will also be recorded at the termination of the test.

A.3.6.2.3 Acceptability of Test Results

For test results to be acceptable, mean survival in the laboratory control tests must be at least 90 percent.

A.3.6.2.4 Data Interpretation

The effects measured in the earthworm toxicity tests are mortality and growth, while the effect measured in the earthworm bioaccumulation test is COPEC concentrations within earthworm tissue. Results of the toxicity and bioaccumulation testing will be interpreted as described in Chapter 10 of the BERA Problem Formulation and Study Design report.

Table A-3

Summary of Test Conditions for Earthworm Survival and Bioaccumulation Test Baby Bains Gap Road Ranges BERA

Parameter	Condition
Test Type	Static
Soil Temperature	20 ± 2°C
Light Quality	Ambient laboratory light
Light Intensity	540 – 1,080 lux
Photoperiod	Continuous illumination
Test Vessel Type and Size	1 liter glass jar with screw-top lid and air hole
Test Soil Mass	200 grams
Test Soil pH	> 4 and < 10
Laboratory Control Soil	10% 2.36 mm screened sphagnum peat, 20% colloidal kaolinite clay, and 70 % grade 70 silica sand
Test Soil Moisture Content	75% water holding capacity
Test Soil Renewal	None
Test Organism Age	> 60 days
Number of Test Organisms per Chamber	10
Number of Replicate Chambers	5
Feeding Regime	No feeding, unless reference site mortality is 20% or greater, or if the total mean weight of worms in reference soil decreases 30% or more
Test Soil Dilution	None (100% undiluted site soil)
Test Duration	28 days
Effects Measured	Mortality, growth, and tissue analysis for COPEC concentrations

A.3.6.3 Perennial Ryegrass Toxicity Testing

Surface soil used for perennial ryegrass toxicity testing will be "split" from the soil samples used for chemical analysis. The 28-day perennial ryegrass toxicity tests will be conducted using the perennial ryegrass *Lolium perenne* as described in *Standard Guide for Conducting Terrestrial Plant Toxicity Tests* (ASTM, 1998).

A.3.6.3.1 Test Initiation

Perennial ryegrass toxicity tests will begin within 10 days of test soil collection. Immediately prior to testing, the temperature of the test soils will be adjusted to 20 ±2 degrees Celsius (°C). Test conditions are presented in Table A-4.

Test soils will be hydrated with deionized water to create a moist testing environment. The perennial ryegrass test soils will be hydrated to 85 percent of water holding capacity. Each soil sample will have five replicate containers each containing 200 grams (dry weight) of test soil. Ten seeds will be placed into the soil in each of the soil containers at a depth of two times the seed diameter. The tests will be incubated within an environmental chamber to give soil temperature of 20 ± 2°C with a photoperiod of sixteen hours of light and eight hours of dark. Lighting will be at ambient laboratory levels, which is approximately 540 to 1,080 lux.

A.3.6.3.2 Termination of the Test

The primary data collected from this study will be the number of seedlings out of the total number of seeds planted that emerge above the soil. All measurements will be taken after termination of the test (28 days post planting). Additional measurements that will be made at the termination of the test are plant height above the soil surface, above-ground biomass, root length, and below-ground biomass.

Shoot length measurements (height above soil surface) are made from the transition point between the hypocotyl and root to the tallest point on the shoot. Root length measurements are made from the transition point between the hypocotyl and root to the tip of the root. Above-ground biomass and below-ground biomass will be measured by separating the above-ground portion of the plant from the below-ground portion of the plant, placing each in a separate pre-weighed drying vessel, and placing in a drying oven set at 70 °C until constant weight is achieved (approximately 24 hours). The total weight of the above-ground biomass and below-ground biomass from each soil sample will them be recorded to the nearest 0.001 gram.

A.3.6.3.3 Acceptability of Test Results

For test results to be acceptable, mean germination success in the laboratory control tests must be at least 90 percent.

A.3.6.3.4 Data Interpretation

The effects measured in the perennial ryegrass toxicity tests are germination success and growth. Results of the perennial ryegrass toxicity testing will be interpreted as described in Section 10 of the BERA Problem Formulation and Study Design report.

Table A-4

Summary of Test Conditions for Perennial Ryegrass Germination and Growth Test Baby Bains Gap Road Ranges BERA

Parameter	Condition
Test Type	Static
Soil Temperature	20 ± 2°C
Light Quality	Ambient laboratory light
Light Intensity	540 – 1,080 lux
Photoperiod	16 hours light: 8 hours dark
Test Vessel Type and Size	Petri dish
Test Soil Mass	200 grams
Test Soil pH	> 4 and < 10
Laboratory Control Soil	10% 2.36 mm screened sphagnum peat, 20% colloidal kaolinite clay, and 70 % grade 70 silica sand
Test Soil Moisture Content	85% water holding capacity
Test Soil Renewal	None
Test Organism Age	Seeds
Number of Seeds per Chamber	10
Number of Replicate Chambers	5
Watering Regime	Daily in order to maintain 85% soil holding capacity
Test Soil Dilution	None (100% undiluted site soil)
Test Duration	28 days
Effects Measured	Percent germination, shoot length, above-ground biomass, root length, below-ground biomass

A.3.6.4 Terrestrial Plant Collection and Analysis

Terrestrial plants will be collected and analyzed for TAL metals in order to assess the bioavailability of COPECs is soil and the potential for COPEC accumulation in terrestrial plant tissues. Plants will be collected from the same locations as the soil samples used for earthworm and plant toxicity testing (9 on-site samples and 1 off-site reference location). Collecting plants from the same locations as the soil samples will ensure that a broad spectrum of COPEC soil concentrations will be assessed and incorporated into the analysis. Only the above-ground

portions of the plants will be sampled since most herbivores and omnivores only eat the above-ground portion of the plant. An attempt will be made to collect grass species since the terrestrial plant toxicity testing will be conducted with a grass species, and collecting a similar species will allow for inferences to be made regarding plant bioaccumulation and potential toxic responses.

A.3.6.4.1 Plant Sample Collection

Plant samples will be collected by cutting the above-ground portion of the plant as close to the ground surface as possible with a pair of scissors. All loose dirt will be removed from the plant sample by physical action prior to placement into their respective sample containers. The plant samples will then be transferred to a plastic bag and placed in a cooler with ice.

A.3.6.4.2 Decontamination Procedures

All equipment used for collection of terrestrial plant samples will be properly decontaminated prior to collecting samples and between sampling locations, as described in the Installation-Wide Sampling and Analysis Plan (IT, 2002).

A.3.6.4.3 Sample Labeling, Packaging, and Shipment

All terrestrial plant tissue samples will be labeled, packaged, and shipped to the appropriate analytical laboratory as presented in the Installation-Wide Sampling and Analysis Plan (IT, 2002).

A.3.6.4.4 Plant Tissue Analysis

As presented in Table A-3, chemical analyses of terrestrial plant tissues will include TAL metals.

A.4.0 Safety and Health and Unexploded Ordnance Support

All work conducted in conjunction with the BERA for the BBGR Ranges will be conducted in accordance with the August 2001, Site Specific Safety and Health Plan and Site-Unexploded Ordnance Safety Plan Attachments to the Site-Specific Field Sampling Plan for the Baby Bains Gap Road Ranges. These attachments will be updated to be consistent with the Installation-Wide Sampling and Analysis Plan (IT, 2002).

A.5.0 References

American Society for Testing and Materials (ASTM), 1998, ***Standard Guide for Conducting Terrestrial Plant Toxicity Tests***, ASTM, West Conshohocken, PA, E 1963-98.

Shaw Environmental, Inc., 2004, ***Remedial Investigation Report, Baby Bains Gap Road Ranges, Fort McClellan, Calhoun County, Alabama***, August.

IT Corporation (IT), 2002, ***Installation-Wide Sampling and Analysis Plan, Fort McClellan, Calhoun County, Alabama***, Revision 3, February.

Neuhauser, E.F., R.C. Loehr, D.L. Milligan, and M.R. Malecki, 1985, "Toxicity of Metals to the Earthworm *Eisenia fetida,*" ***Biol. Fertil. Soils***, 1: 149 - 152.

U.S. Environmental Protection Agency (EPA), 2005, ***Ecological Soil Screening Levels for Lead***, Office of Solid Waste and Emergency Response, Washington, D.C., OSWER Directive 9285.7-70.

APPENDIX B

FIELD SAMPLING AND ANALYSIS PLAN FOR SEDIMENT AT THE BABY BAINS GAP ROAD RANGES

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B.1.0 Introduction

The results of the screening-level ecological risk assessment (SLERA) for the Baby Bains Gap Road (BBGR) Ranges (Shaw Environmental, Inc., 2004) indicated that copper, lead, and gamma-chlordane were identified as constituents of potential ecological concern (COPEC) in the sediment of Ingram Creek and its tributaries in the vicinity of the BBGR Ranges. To provide information for the baseline ecological risk assessment (BERA), sediment samples will be collected and analyzed for target analyte list (TAL) metals, volatile organic compounds (VOC), semivolatile organic compounds (SVOC), chlorinated pesticides, organophosphorus pesticides, and chlorinated herbicides. In addition, sediment samples will be analyzed for toxicity to chironomid larva. COPEC concentrations in sediments will also be used in food web models to predict the total daily doses of COPECs in riparian invertivorous mammals and birds.

B.2.0 Site Selection

Twelve sediment samples will be collected from locations representative of the full range of lead detected in historical sediment samples collected at the BBGR Ranges. Sediment will also be collected from a stream with similar substrate characteristics as South Branch of Cane Creek and Ingram Creek and their tributaries but outside the influence of the BBGR Ranges to serve as reference sediment for the toxicity tests. Lead in sediment will be used as an indicator of potential contamination as it is a known component of small-arms ammunition and has been detected in areas of known contamination. Therefore, it will be assumed that the level of lead contamination will also give an indication of contamination by other munitions-related constituents. Additionally, the benthic invertebrate community will be analyzed using the rapid bioassessment protocol II (RBP II) (Barbour et al., 1999) at each of the 12 sediment sample locations and the reference site. The proposed sediment sample locations are presented in Figure 9-2 and are also summarized in Table 9-2 of the BERA Problem Formulation and Study Design report.

B.3.0 Sampling and Analysis Procedures

Unless otherwise specified, sample collection procedures will follow the *Installation-Wide Sampling and Analysis Plan* (SAP) (IT, 2002). Sediment samples will be collected from the farthest downstream location first and then proceed upstream. The benthic macroinvertebrate community at each sediment sampling location will then be evaluated using the RBP II procedure.

B.3.1 Sediment Sampling

Prior to the collection of sediment samples, in-stream water quality measurements of the following parameters will be recorded:

- pH
- Conductivity
- Dissolved oxygen
- Temperature
- Turbidity
- Oxidation reduction potential.

At each sediment sampling location, the water depth, stream width, substrate type, and approximate flow velocity will also be recorded. Other observations that may be recorded include weather conditions, surrounding vegetative cover and evidence of erosion.

Sediment samples (Table B-1) will be collected to a depth of 0.5 feet with stainless steel spoons or trowels and homogenized in a stainless steel bowl following the procedures outlined in the SAP (IT, 2002). A list of the sample containers and preservatives required for each analysis for sediment samples is also provided in the SAP (IT, 2002).

B.3.2 Rapid Bioassessment

A biological assessment of the benthic invertebrate community using the EPA Rapid Bioassessment Protocol II (RBP II) will be performed at each sediment sampling location. RBP II will be used to determine whether on-site benthic invertebrate community structure at the BBGR Ranges is significantly different than benthic community structure in the reference stream.

The locations for benthic invertebrate community analysis will be co-located with the sediment sample locations. The sampling locations will be located in areas of similar habitat so that the benthic community can be evaluated under similar environmental conditions.

RBP II as developed by EPA (Plafkin, et al., 1989) will be used to quantitatively assess the biotic health of the benthic community in South Branch of Cane Creek and Ingram Creek and their tributaries in the vicinity of the BBGR Ranges. RBPs were initially designed as a relatively inexpensive screening tool for use in determining if freshwater streams were capable of supporting designated aquatic life uses. However, according to EPA, the bioassessment protocols have also been found useful in characterizing the existence and severity of use

Table B-1

Sediment Sample Designations and Quality Assurance/Quality Control Samples
BERA Study Design for the Baby Bains Gap Road Ranges
Fort McClellan, Alabama

Sample Location	Sample Designation	Sample Depth (ft)	QA/QC Samples		Analytical Parameters
			Field Duplicates[a]	MS/MSD[a]	
HR-74Q-SD01/ HR-74Q-RPB01	HR-74Q-SD01-SD-RW1001-REG	0.5			TAL Metals by SW6010B/SW7470A, VOCs by 8260B, SVOCs by 8270C, Chlorinated Pesticides by 8081A, Organophosphorus Pesticides by 8141A, and Chlorinated Herbicides by 8151A. TOC by Walkley Black, pH by SW9045C, Grain Size by ASTM 421/422, *Chironomus riparius* 10-day Survival and Growth Test by EPA 100.2.
CWM-183-SD02/ CWM-183-RPB02	CWM-183-SD02-SD-RW1002-REG	0.5	CWM-183-SD02-SD-RW1003-FD		TAL Metals by SW6010B/SW7470A, VOCs by 8260B, SVOCs by 8270C, Chlorinated Pesticides by 8081A, Organophosphorus Pesticides by 8141A, and Chlorinated Herbicides by 8151A. TOC by Walkley Black, pH by SW9045C, Grain Size by ASTM 421/422, *Chironomus riparius* 10-day Survival and Growth Test by EPA 100.2.
FTA-163-SD02/ FTA-163-RPB02	FTA-163-SD02-SD-RW1004-REG	0.5			TAL Metals by SW6010B/SW7470A, VOCs by 8260B, SVOCs by 8270C, Chlorinated Pesticides by 8081A, Organophosphorus Pesticides by 8141A, and Chlorinated Herbicides by 8151A. TOC by Walkley Black, pH by SW9045C, Grain Size by ASTM 421/422, *Chironomus riparius* 10-day Survival and Growth Test by EPA 100.2.
HR-83Q-SD01/ HR-83Q-RPB01	HR-83Q-SD01-SD-RW1005-REG	0.5			TAL Metals by SW6010B/SW7470A, VOCs by 8260B, SVOCs by 8270C, Chlorinated Pesticides by 8081A, Organophosphorus Pesticides by 8141A, and Chlorinated Herbicides by 8151A. TOC by Walkley Black, pH by SW9045C, Grain Size by ASTM 421/422, *Chironomus riparius* 10-day Survival and Growth Test by EPA 100.2.
HR-223Q-SD01/ HR-223Q-RPB01	HR-223Q-SD01-SD-RW1006-REG	0.5		HR-223Q-SD01-SD-RW1006-MS/MSD	TAL Metals by SW6010B/SW7470A, VOCs by 8260B, SVOCs by 8270C, Chlorinated Pesticides by 8081A, Organophosphorus Pesticides by 8141A, and Chlorinated Herbicides by 8151A. TOC by Walkley Black, pH by SW9045C, Grain Size by ASTM 421/422, *Chironomus riparius* 10-day Survival and Growth Test by EPA 100.2.
HR-76Q-SD02/ HR-76Q-RPB02	HR-76Q-SD02-SD-RW1007-REG	0.5			TAL Metals by SW6010B/SW7470A, VOCs by 8260B, SVOCs by 8270C, Chlorinated Pesticides by 8081A, Organophosphorus Pesticides by 8141A, and Chlorinated Herbicides by 8151A. TOC by Walkley Black, pH by SW9045C, Grain Size by ASTM 421/422, *Chironomus riparius* 10-day Survival and Growth Test by EPA 100.2.
HR-76Q-SD03/ HR-76Q-RPB03	HR-76Q-SD03-SD-RW1008-REG	0.5			TAL Metals by SW6010B/SW7470A, VOCs by 8260B, SVOCs by 8270C, Chlorinated Pesticides by 8081A, Organophosphorus Pesticides by 8141A, and Chlorinated Herbicides by 8151A. TOC by Walkley Black, pH by SW9045C, Grain Size by ASTM 421/422, *Chironomus riparius* 10-day Survival and Growth Test by EPA 100.2.

Table B-1

Sediment Sample Designations and Quality Assurance/Quality Control Samples
BERA Study Design for the Baby Bains Gap Road Ranges
Fort McClellan, Alabama

Sample Location	Sample Designation	Sample Depth (ft)	QA/QC Samples		Analytical Parameters
			Field Duplicates[a]	MS/MSD[a]	
HR-79Q-SD01/ HR-79Q-RPB01	HR-79Q-SD01-SD-RW1009-REG	0.5			TAL Metals by SW6010B/SW7470A, VOCs by 8260B, SVOCs by 8270C, Chlorinated Pesticides by 8081A, Organophosphorus Pesticides by 8141A, and Chlorinated Herbicides by 8151A. TOC by Walkley Black, pH by SW9045C, Grain Size by ASTM 421/422, *Chironomus riparius* 10-day Survival and Growth Test by EPA 100.2.
HR-79Q-SD03/ HR-79Q-RPB03	HR-79Q-SD03-SD-RW1010-REG	0.5			TAL Metals by SW6010B/SW7470A, VOCs by 8260B, SVOCs by 8270C, Chlorinated Pesticides by 8081A, Organophosphorus Pesticides by 8141A, and Chlorinated Herbicides by 8151A. TOC by Walkley Black, pH by SW9045C, Grain Size by ASTM 421/422, *Chironomus riparius* 10-day Survival and Growth Test by EPA 100.2.
HR-79Q-SD02/ HR-79Q-RPB02	HR-79Q-SD02-SD-RW1011-REG	0.5	HR-79Q-SD02-SD-RW1012-FD		TAL Metals by SW6010B/SW7470A, VOCs by 8260B, SVOCs by 8270C, Chlorinated Pesticides by 8081A, Organophosphorus Pesticides by 8141A, and Chlorinated Herbicides by 8151A. TOC by Walkley Black, pH by SW9045C, Grain Size by ASTM 421/422, *Chironomus riparius* 10-day Survival and Growth Test by EPA 100.2.
HR-79Q-SD05/ HR-79Q-RPB05	HR-79Q-SD05-SD-RW1013-REG	0.5			TAL Metals by SW6010B/SW7470A, VOCs by 8260B, SVOCs by 8270C, Chlorinated Pesticides by 8081A, Organophosphorus Pesticides by 8141A, and Chlorinated Herbicides by 8151A. TOC by Walkley Black, pH by SW9045C, Grain Size by ASTM 421/422, *Chironomus riparius* 10-day Survival and Growth Test by EPA 100.2.
New Sediment Sample Location	____-SD-RW1014-REG	0.5			TAL Metals by SW6010B/SW7470A, VOCs by 8260B, SVOCs by 8270C, Chlorinated Pesticides by 8081A, Organophosphorus Pesticides by 8141A, and Chlorinated Herbicides by 8151A. TOC by Walkley Black, pH by SW9045C, Grain Size by ASTM 421/422, *Chironomus riparius* 10-day Survival and Growth Test by EPA 100.2.
Reference[b]	____-SD-RW1015-REG	0.5			TAL Metals by SW6010B/SW7470A, VOCs by 8260B, SVOCs by 8270C, Chlorinated Pesticides by 8081A, Organophosphorus Pesticides by 8141A, and Chlorinated Herbicides by 8151A. TOC by Walkley Black, pH by SW9045C, Grain Size by ASTM 421/422, *Chironomus riparius* 10-day Survival and Growth Test by EPA 100.2.

[a] Field duplicates and MS/MSDs are collected for chemical analysis only and not for biological testing.

[b] Reference location will be selected onsite from a comparable adjoining watershed.

FD - Field duplicate.
FS - Field split.
MS/MSD - Matrix spike/matrix spike duplicate.
QA/QC - Quality assurance/quality control.
REG - Field sample.
TAL - Target analyte list.
VOCs - Volatile organic compounds.
SVOCs - Semivolatile organic compounds.
TOC - Total Organic Carbon.

impairment within freshwater systems including full watersheds, as well as identifying sources and causes to the impairment. RBP II is well-suited for screening the streams within FTMC for biotic integrity.

At each sampling location, water quality measurements will be obtained. Habitat quality observations including substrate type, surrounding land use, evidence of erosion and pollutant sources, vegetative stream canopy, and other relevant data will be noted.

B.3.2.1 Macroinvertebrate Sampling

Two macroinvertebrate samples will be collected at each sampling station, the riffle/run sample will be collected with a kick net and the coarse particulate organic matter (CPOM) sample will be collected by hand.

B.3.2.1.1 Kick Net Samples

The kick net sample provides data as to the abundance of the scraper and filtering collector functional feeding groups and is generally collected in a riffle and run area of the stream. The riffle and run sample will be composited in the field for processing as one sample per location. The kick net consists of a 0.9 mm mesh bag attached to a rectangular 8 by 18-inch frame mounted on a handle. The use of the sampler is described as follows:

1. The sampler is positioned securely on the substrate with the opening of the net facing upstream.

2. An area of 1 square meter immediately upstream of the sampler is disturbed by overturning and scraping rocks and large stones by shifting the feet to dislodge clinging or attached organisms. Any rocks or other large items that have been swept into the net are examined to ensure that organism removal is complete.

3. The remaining sediment is agitated with the feet to dislodge epibenthic and burrowing organisms.

All organisms and debris such as sticks and leaves will be removed from the kick net bag and placed into a container with 95% ethanol to preserve the organisms.

B.3.2.1.2 Coarse Particulate Organic Matter Samples

One CPOM sample will be collected at each location from depositional areas with low current velocity within the stream. The CPOM sample, which provides data as to the abundance of the shredder feeding group, will be collected by hand including a composite variety of leaves, twigs,

bark and other fragments. The collected material and organisms will be placed into a sample container with 95% ethanol.

B.3.3 Decontamination Procedures

All equipment used for collection, homogenization, and transfer will be properly decontaminated prior to collecting samples and between sampling locations, as described in the SAP (IT, 2002).

B.3.4 Quality Assurance/Quality Control Samples

As established by the DQO process, field and laboratory QA/QC indicator soil samples and analyses will be collected to provide information concerning the measured quality and usability of the field data. As presented in the SAP (IT, 2002), the frequency of field duplicates, MS/MSDs, and equipment rinse blanks will be 1 in 10 (10%), 1 in 20 (5%), and once per sampling event, respectively.

B.3.5 Sample Labeling, Packaging, and Shipment

All prepared samples will be labeled, packaged, and shipped to the appropriate analytical or biological testing laboratory as presented in the SAP (IT, 2002).

B.3.6 Chemical Analysis

As presented in Table B-1, chemical analyses of sediment collected for chironomid toxicity testing will include TAL metals, VOCs, SVOCs, chlorinated pesticides, organophosphorus pesticides, chlorinated herbicides, total organic carbon, pH, and grain size. Chemical analyses of chironomid tissue after termination of the toxicity tests will include TAL metals and pesticides (Table B-2)

B.3.7 Biological Testing

Biological testing of sediments collected at the BBGR Ranges will consist of toxicity testing and a bioaccumulation study of the benthic invertebrate *Chironomus riparius*.

B.3.7.1 Test Objective

The direct toxicity of sediment-bound COPECs will be measured by exposing benthic invertebrates (*Chironomus riparius*) to streambed sediment. Use of chironomids to measure toxicity of sediment-associated contaminants is quite common and has been standardized by EPA (EPA, 2000).

Measuring growth as well as survival over the 10-day exposure period permits an evaluation of chronic (sub-lethal) endpoints in addition to acute toxicity. Adverse sub-lethal responses could

Table B-2

Chironomid Tissue Sample Designations
BERA Study Design for the Baby Bains Gap Road Ranges
Fort McClellan, Alabama

Sample Location	Sample Designation	QA/QC Samples			Analytical Suite
		Field Duplicates	Field Splits	MS/MSD	
HR-74Q-SD01	HR-74Q-SD01-MIDG-RW9000C-REG				TAL Metals by SW6010B/SW7471A, Chlorinated Pesticides by 8081A
CWM-183-SD02	CWM-183-SD02-MIDG-RW9001C-REG				TAL Metals by SW6010B/SW7471A, Chlorinated Pesticides by 8081A
FTA-163-SD02	FTA-163-SD02-MIDG-RW9002C-REG				TAL Metals by SW6010B/SW7471A, Chlorinated Pesticides by 8081A
HR-83Q-SD01	HR-83Q-SD01-MIDG-RW9003C-REG				TAL Metals by SW6010B/SW7471A, Chlorinated Pesticides by 8081A
HR-223Q-SD01	HR-223Q-SD01-MIDG-RW9004C-REG				TAL Metals by SW6010B/SW7471A, Chlorinated Pesticides by 8081A
HR-76Q-SD02	HR-76Q-SD02-MIDG-RW9005C-REG				TAL Metals by SW6010B/SW7471A, Chlorinated Pesticides by 8081A
HR-76Q-SD03	HR-76Q-SD03-MIDG-RW9006C-REG				TAL Metals by SW6010B/SW7471A, Chlorinated Pesticides by 8081A
HR-79Q-SD01	HR-79Q-SD01-MIDG-RW9007C-REG				TAL Metals by SW6010B/SW7471A, Chlorinated Pesticides by 8081A
HR-79Q-SD03	HR-79Q-SD03-MIDG-RW9008C-REG				TAL Metals by SW6010B/SW7471A, Chlorinated Pesticides by 8081A
HR-79Q-SD02	HR-79Q-SD02-MIDG-RW9009C-REG				TAL Metals by SW6010B/SW7471A, Chlorinated Pesticides by 8081A
HR-79Q-SD05	HR-79Q-SD05-MIDG-RW9010C-REG				TAL Metals by SW6010B/SW7471A, Chlorinated Pesticides by 8081A
New Location	____-MIDG-RW9011C-REG				TAL Metals by SW6010B/SW7471A, Chlorinated Pesticides by 8081A
SED-REF	SED-REF-MIDG-RW9012C-REG				TAL Metals by SW6010B/SW7471A, Chlorinated Pesticides by 8081A

FD - Field duplicate.
FS - Field split.
MS/MSD - Matrix spike/matrix spike duplicate.
QA/QC - Quality assurance/quality control.
REG - Field sample.
TAL - Target analyte list.
TOC - Total organic carbon.
SED-REF - Sediment reference location collected from a comparable adjoining watershed.

affect the long-term viability of benthic invertebrate communities within impact zones and, therefore, affect the stability of the stream ecosystem.

The assessors are proposing use of *Chironomus riparius* rather than *C. tentans*, because historical data indicate that *Chironomus riparius* is more sensitive to metal toxicity than *C. tentans*. Since the sediment-bound COPECs are metals and one pesticide, use of the more sensitive *C. riparius* should be a better indication of risk from a weight of evidence standpoint. A summary of the test conditions is provided in Table B-3.

B.3.7.2 Test Sediment Dilution Series

Given the uncertainties and difficulties associated with laboratory dilution and subsequent mixing of sediments, test organisms will be exposed to 100 percent undiluted field collected sediment. Tests will be set up with exposure to laboratory-based synthetic control sediment, reference sediment, and on-site sediment representing the full range of lead concentrations detected in historical sediment samples from the BBGR Ranges.

B.3.7.3 Test Initiation

Tests will be initiated within 10 days of sample collection, and the laboratory grade overlying test water will be maintained at 23 $\pm$ 1°C. Test chambers will consist of 300 ml high form lipless beakers containing 100 mg of sediment and 175 ml of overlying water. Ten second-to-third instar *C. riparius* midges (approximately 10 days old) will be used at test initiation. A total of 8 replicates will be employed for each parallel test.

Midges within each test chamber will be fed 1-5 ml of a 4-g/l tetrafin suspension on a daily basis throughout the 10-day test period. Each replicate test chamber will receive two-volume additions/day of overlying water. Water renewals will be conducted in a manner that minimizes suspension of sediment. All testing will, therefore, be static daily renewals with careful monitoring of physico-chemical parameters within the overlying water. These parameters will include pH, temperature, ammonia, alkalinity, hardness, conductivity, and dissolved oxygen.

B.3.7.4 Test Monitoring

All chambers will be checked daily and observations made to assess test organism behavior such as sediment avoidance.

B.3.7.5 Measurement of Overlying Water-Quality Characteristics

Conductivity, hardness, pH, alkalinity, and ammonia will be measured in all treatments at the beginning and end of a test. Overlying water will be sampled just before water renewal from about 1 to 2 cm above the sediment surface using a pipet.

B.3.7.6 Test Termination

Immobile organisms isolated from the sediment surface or from sieved material will be considered dead. A #40 sieve (425-µm mesh) will be used to remove midges from sediment. Surviving midges will be isolated from pans.

B.3.7.7 Test Data

Ash-free dry weight (AFDW) and survival will be the endpoints measured at the end of the 10-day sediment toxicity test.

For determination of AFDW, all living larvae in each replicate will be pooled and the sample will be dried to a constant weight (e.g., 60 °C for 24 hours). At the termination of the test and after determination of AFDW, each pooled sample will be analyzed for the COPECs as presented in Table B-2.

Table B-3
Summary of *Chironomus Riparius* Survival and Growth Test

	Parameter	Conditions
1.	Test Type	Whole-sediment toxicity with renewal of overlying water
2.	Temperature	23 ± 1°C
3.	Light Quality	Wide-spectrum fluorescent lights
4.	Illuminance	~100 – 1,000 lux
5.	Photoperiod	16 hours light:8 hours dark
6.	Test chamber	300-ml high form lipless beaker
7.	Sediment volume	100 ml
8.	Overlying water volume	175 ml
9.	Renewal of overlying water	2 volume additions per day, either continuous or Intermittent
10.	Age of organisms	<24 hour old larvae at start of test
11.	Number of organisms per chamber	10
12.	Number of replicate chambers per treatment	8

	Parameter	Conditions
13.	Feeding	Tetrafin goldfish food, fed 1.5 ml daily to each test chamber starting day-1. If fungal or bacterial growth develops on sediment surface, feeding should be suspended for one or more days. If DO drops below 2.5 mg/L during the test, feeding should be suspended for the amount of time necessary to increase the DO. If feeding is suspended in one treatment, it is suspended in all treatments.
14.	Aeration	None, unless DO in overlying water drops below 2.5 mg/L
15.	Overlying water	Culture water, laboratory-grade freshwater, or reconstituted water
16.	Test chamber cleaning	Gently brush outside of overflow screens if they become clogged
17.	Overlying water quality	Hardness, alkalinity, conductivity, and ammonia at the beginning and at the end of the test (day 10). Temperature daily. DO and pH three times/week. Conductivity weekly. Concentrations of DO should be measured more often if DO has declined by more than 1 mg/L since previous measurement. Overlying water quality should be measured just prior to water renewals. Overlying water should be measured from about 1 to 2 cm above the sediment surface.
18.	Test duration	Eight replicates are ended at 10 days for survival and weight.
19.	Endpoints	10-day survival and weight; COPEC concentrations in chironomid tissues
20.	Test acceptability	Average size of *C. riparius* in control sediment at 10 days $\geq$ 0.6 mg/surviving organism as dry weight or 0.48 mg/surviving organisms as AFDW. Emergence $\geq$ 50%

B.4.0 Health and Safety and Unexploded Ordnance Support

All work conducted during the BERA for the BBGR Ranges will be conducted in accordance with the Site Specific Safety and Health Plan and Site-Unexploded Ordnance Safety Plan Attachments to the Site-Specific Field Sampling Plan for the Baby Bains Gap Road Ranges. These attachments will be updated to be consistent with the SAP for the final BERA study design for the BBGR Ranges.

B.5.0 References

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